Urban Agriculture in office buildings, applications for the Teaching of office buildings design projects for Architectural students in Vietnam

First A. Hai-Yen Hoang

Head of Architecture Department, Faculty of Architecture and Art, Ho Chi Minh City University of Technology (HUTECH), 475A Dien Bien Phu Street, 25 Ward, Binh Thanh District, HCMC, Vietnam

hh.yen84@hutech.edu.vn

Abstract

The speed of urbanization is increasing rapidly in Vietnam's big cities. The population is crowded in big cities and office buildings are rising higher and higher. The demand for office building designs have increased, making teaching Architectural students to master sustainable design trends for office buildings necessary at Architecture Universities in Vietnam. The office buildings that have been built are mainly glass-covered concrete blocks, using artificial air-conditioning equipment that release a large amount of CO_2, polluting the environment, increasing urban heat, and little attention is given to the development of green spaces. Bringing Urban Agriculture into office buildings is a viable new direction that many developed countries have applied. This research analyses the current situation of office buildings that have been built in Vietnam to assess the necessity for training Architecture students about new sustainable design trends. Since then, the article proposes the application of solutions for Urban Agriculture in the design of office buildings, proposed in Teaching Architecture students in Vietnam, such as using vegetable growing boxes, using LED lights, vegetable growing towers, Aquaponics, and using automatic vegetable growing machines. Giving students access to new sustainable design trends while they are studying is a positive move to create a future generation of Architects who have mastered sustainable design solutions to construct green buildings and cities that are close to nature, and also support life and human development.

Key words: Urban Agriculture, green office, Architecture students, sustainable design, Vietnam.

1 Introduction

The speed of urbanization in Vietnam has been increasing in recent years. The development of high-rise buildings hasn't been accompanied by the maintenance of green areas, which makes urban areas in Vietnam a concrete jungle, releasing a large amount of CO_2 into the air, leading to the polluting of the environment, the greenhouse effect, and the urban heat island phenomenon. Urbanization reduces the area of Agricultural land, causing Urban Agriculture to develop. Since the end of the 20^{th} century, Urban Agriculture has become a trend in the process of urban development in many countries.

High-rise office buildings are currently the type of buildings that are built a lot in Vietnam's big cities, requiring Architects and Architecture students to master new principles and sustainable design trends for this building type. Currently, office buildings are built mainly of glass-covered concrete blocks, using artificial air conditioners. Few investors are interested in putting more trees into the buildings, planting agricultural trees to turn them into self-sufficient buildings, helping to ensure spaces are green, and transmitting positive energy to employees. Scientists have shown that humans have always needed to be

near nature, so efforts to bring green spaces into office buildings are now essential. This is also a new research direction in Teaching Architecture students to do office building design projects at universities in Vietnam.

With the advancement of science and technology, the prevalence of green technology and smart buildings are growing. In addition to the use of natural energy sources, reuse of waste can turn office buildings into vertical farms. This is a positive direction for a green office buildings model in the future.

Developed countries have successfully applied the model of Urban Agriculture in office buildings. Vietnam can fully apply this model when designing office building. This is a new and feasible direction that needs to be taught to Architecture students in Vietnamese universities in order to create a generation of Architects who design with sustainable development and human protection in mind.

1.1 Urban Agriculture

Urban Agriculture is defined as the use of small areas, vacant lots, gardens, lawns, balconies, terraces, and other available unused space in big cities to plant trees or raise poultry and small animals in accordance with conditions of land, climate, and hydrology. The aim is to ensure ecological balance, create production efficiencies, economic efficiency, and contribute to improving the quality of the environment. In addition, all or some of the produce is commercialized. (Huong-Giang, 2018)

1.2 Green office building design projects

Green office building design is taking advantage of the plants and flowers function to decorate the office interior, so that the design is appropriate and highly aesthetic. Office supplies are made from recycled materials. The green of trees not only brings beauty, but also helps to filter air and reduce stress. An office that is called a green office will ensure the following elements: efficient use of energy, an indoor environmental strategy, advanced architecture, identity, and sustainability. (Luc-Binh, 2018)

Office building design projects form part of the 3rd year of Architecture studies in Vietnam. They require students to design a medium-sized office building with a construction area of about 600- 800m^2, with full public utilities and offices for lease. Students should be encouraged to have solutions for green office and use eco office design principles in these projects.

2 Research Methodology

This paper is a qualitative research, using a mixed method consisting of the data synthesis method and expert method. The data synthesis method is applied to analyze the situation of office buildings that have been built in Vietnam, thereby pointing out the shortcomings and the importance of training Architects in sustainable design trends. The data synthesis method is also used to refer to the experience of Urban Agriculture development in office buildings around the world. The expert method is applied to collect Urban Agriculture models that are being used in Vietnam, thereby providing solutions as design principles to apply those models in different spaces in the office buildings, combined with green architecture solutions to create sustainable eco office buildings.

3 Experience of applying Urban Agriculture in office buildings around the world

3.1 The Japanese experience

The headquarters of Pasona Group has the main goal of creating a building in harmony with nature. This is the workplace of 1500 employees, trained in farming by agricultural experts. All employees grow their own food. The building is a typical model of Urban Agriculture in high-rise buildings, focusing on environmental protection. All 9 floors are covered with green spaces, using energy-saving light sources and advanced irrigation techniques. The temperature inside the building is carefully controlled to ensure the optimal yield of the plants. After witnessing and participating in tree planting and tending activities, 80% of employees said they felt positive, energized and increased their motivation to work. Another advantage of growing houseplants is that there are no pests. Therefore, no pesticides are required and all harvested products are 100% organic. (Hong-Nhung, 2018)

Figure 1: Trees help offset carbon Emissions (Source: Kono Designs).

Figure 2: Employees are harvesting rice (Source: Dezeen).

3.2 The Indian experience

The Hyperion building, designed by Belgian Architect Vincent Callebaut, is an eco-friendly building with lush green gardens. The ecological building is 36 floors high and consists of 1,000 apartments, along with office area and workspace, a gym, restaurants and a swimming pool.

Figure 3: Hyperion is a sustainable Agricultural project that is resistant to climate change (ABIGAIL BEALL FOR MAILONLINE, 2016).

The Hyperion building will be designed with urban farms and small livestock farms producing eggs and milk. It is designed to work under the model of "self-sufficiency". It is estimated that every square meter in this farm can produce 20 kg of organic fruits and vegetables.

The buildings will be equipped with solar panels. Energy for the buildings is generated through wind turbines and photovoltaic systems. In addition, Agricultural by-products from the farms will be converted to methane to generate energy for use in buildings. Rainwater will be collected for irrigation and to replenish groundwater. Hyperion is a sustainable Agriculture project that is resistant to climate change through its healthy ecosystem and environment. (ABIGAIL BEALL FOR MAILONLINE, 2016)

4 Situation of office buildings that have been built in Vietnam at present, Course Goals and Course Outcomes in Teaching office buildings projects applying Urban Agriculture in Vietnam

4.1 Current situation of office buildings in Vietnam at present

Office buildings that are built in big cities in Vietnam currently are mainly high-rise buildings with reinforced concrete structures covered with glass, that use artificial air-conditioning systems. Office buildings consume a large amount of energy in maintaining daily operations for lighting and artificial air-conditioning. Along with that is the large amount of greenhouse gases released into the environment that raises air temperature, and contribute to climate change and environmental pollution.

Figure 4: Bitexco Office Building and office interior, Ho Chi Minh City, Vietnam (Bitexco Financial Tower).

Many businesses have also realized the importance of creating a green, clean working environment for employees, so green office models have begun to appear in Hanoi and Ho Chi Minh City (Babylon Landscape, 2018). At the forefront of the green office trend and the application of Urban Agriculture to offices is the Vo Trong Nghia Architecture Company office. With the concept of a "Green" design using light, wind and water, natural materials and local materials, Vo Trong Nghia Architects uses contemporary basic design principles, discovering new ways to create green architecture for the 21st century while maintaining traditional Asian architecture.

Figure 5: Office building and interior of Vo Trong Nghia Architects company

(Dezeen Awards, 2019).

Currently the design trend of putting trees into offices is assessed and certified by green building rating standards in Vietnam. The criteria for evaluating green offices in Vietnam include Lotus standards, standards of the Vietnamese Architects Association and Edge standards of IFC of the World Bank Group (Babylon Landscape, 2018). It can be seen that the green office design trend will become indispensable in the future, requiring the training of Architects to master these principles and standards, so that after graduating students can meet the requirements of businesses and society.

4.2 Course Goals

The course includes one theory lesson, with the remained beings project-editing sessions. Students become familiar with the types of green office building architecture. Students grasp the design principles, typical architectural styles of these buildings, master the functional lines and organize the architectural space to ensure optimal operation for an office building. They have to give attention to combining green design solutions and incorporating Urban Agriculture into the building in a reasonable way, without affecting the general function of the building.

4.3 Course Outcomes

- Knowledge: Equip students with the basic knowledge of architectural design methods of office buildings. Provide knowledge of green office building design principles and solutions to bring Urban Agriculture into office building spaces.

- Skills: Students master the design principles and are able to practice in the implementation of green office building design projects, which can be applied for advanced projects at a later stage. Students develop the skills to design high-rise green buildings and incorporate Urban Agriculture solutions into the building.

- Level of autonomy and self-responsibility: Students have the ability to self-study, self-research, know how to recognize and solve cases of the project. Students will have to complete the project with reasonable solutions and show these in the A1 drawings.

5 Steps and criteria for evaluating an office building design project using Urban Agriculture

Making a project based on the Case Study: Bring Urban Agriculture into an office building project.

Figure 6: The design process an office building project (Source: Author, 2020).

The project design process is detailed in the following specific steps:

Step 1: Research design tasks. Detecting problems and ideas of incorporating Urban Agriculture into the design.

Step 2: Analyze and assess the site. Find out the site characteristics and research the proposed solutions for the application of Urban Agriculture.

Step 3: Find ideas, solve problems. Propose preliminary plans about functions and shapes, combine to bring Urban Agriculture spaces into the plan. Offer at least 2 options from which to choose and analyze the pros and cons.

Step 4: Develop the chosen option and solve problems in detail. Giving options of building plan and cubes, with reasonable functional spaces of function and area, as well as the specific plans of cubes and technical solutions for the project when applying Urban Agriculture. This is a process that takes a long time and many lessons to complete.

Step 5: Finalize the project: Show the complete project with technical drawings on A1 papers size, with detailed drawings of the plans, elevations, cross sections and perspectives of the project, as well as specific technical solutions for Urban Agriculture spaces in the building.

6 The application solutions of Urban Agriculture in office building project design, proposed in Architectural Teaching in Vietnam

6.1 Solution to use vegetable growing boxes

One solution is the use of concrete-reinforced vegetable boxes on the building facade or wooden boxes placed on shelves to make partitions in the workspace to grow vegetables. This is the simplest and easiest solution. The use of vegetable boxes on the facade should be incorporated in the initial design of the building, with spaces available for vegetable boxes to be placed later.

Vegetable growing boxes solutions for shelves in workspaces can be more flexible, and can be used to add green space to office spaces, or to be included in interior design drawings from beginning. These vegetable boxes are designed as individual modules, so they can be easily replaced if needed.

Figure 7: Vegetable growing boxes in the office (Source: Author, 2020).

6.2 The use of LED lights to grow agricultural plants in workspaces.

Nowadays in office spaces, the light source used is mainly artificial light. To ensure that agricultural plants can live in the environment lacking natural light, we can use LED lights. In agriculture, LED lights are used to cultivate plant varieties, stimulate plant growth, significantly improve plants density, can provide near-lit lighting without creating a thermal effect that damage the plants, improve quality of

agricultural products, help to increase nutritional value, and reduce nitrate concentration in vegetables. (Ngo, 2016)

LED lights are designed above the planting shelves, providing direct lighting to the plants. These lights can also contribute to decorating the office's interior space. LED lights can also be designed to be hung from the ceiling in a large array, to illuminate a large area of planting in the lobby areas, creating a miniature farm in the heart of the city.

Figure 8: Use LED lights to plant agricultural plants in the office spaces (Ngo, 2016).

6.3 Solutions using vegetable growing towers in office spaces

Another solution is using hydroponic vegetable growing towers suitable for office lobby spaces, as a partition between workspaces, or in meeting rooms. Combined with an automatic irrigation system, the hydroponic vegetable tower can become a trees decorative partition, combined with the interior space to make the working environment closer to nature.

These green spaces act as natural air filters help to improve the quality of air in the office. At the same time, this is also a source of fresh, organic foods for office employees' lunches. Every offices' employees can become farmers who take care of the gardens in their workplaces, harvest products and use them. This is also a method to help them reduce stress and relax after working hours.

The post-hydroponic planting model can combine to create tree party walls in large workspaces. A-shaped or horizontal towers hydroponic vegetables are suitable in large spaces that need decoration, such as office halls or meeting rooms.

Figure 9: Green partitions by vegetable posts (Source: Author, 2020).

Figure 10: A-shaped Hydroponic vegetable towers (Source: Author, 2020).

6.4 Aquaponics application solutions on office roofs

Aquaponics is the combination of Aquaculture and Hydroponics. Aquaponics uses circulating water from an aquarium to provide nutrients to plants. Nitrifying bacteria convert waste from aquariums into nutrients suitable for plants. Water is also filtered out by plants and supplied to the aquarium. This is a circulatory system that perfectly takes advantage of each other. (Phan, 2017)

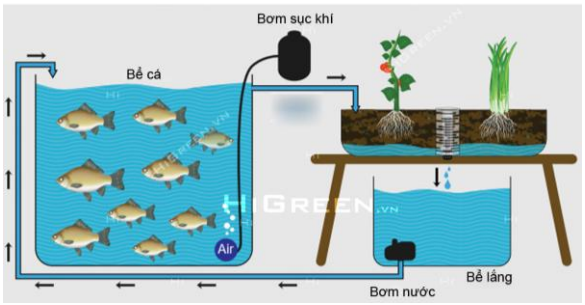

Figure 11: Aquaponics system diagram (Phan, 2017).

There are two methods that can be applied on office buildings rooftops: Aquaponics with shallow irrigation, and shallow water.

In the shallow irrigation method, plants are grown in a tray of terracotta media (depth of about 30cm), at the bottom of the tray, there are holes in the drainage and there is a water breaker. Water from the aquarium through the filter and the pump system is pumped into a vegetable tray. When the amount of water reaches the level of discharge it will be completely discharged to the point where the clean water is disconnected and returned to the aquarium and the process goes on and on. (Aquaponics, 2017)

Figure 12: Aquaponics shallow irrigation method (Aquaponics, 2017).

The shallow water Aquaponics method is suitable for vertical development, with many layers arranged in a small area. This is a method of growing fresh vegetables with a horizontal pipe with shallow water, and nutrients from the aquarium are flowing through the pipe. Vegetables are placed in holes pre-carved at the top of the pipe. (Aquaponics, 2017)

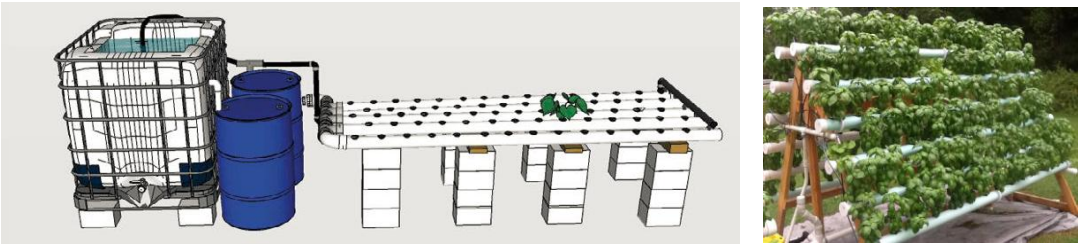

Figure 13: Aquaponics shallow water method (Aquaponics, 2017).

6.5 Use of the T-farm automatic vegetable growing machine

T-Farm is a mini smart garden, designed to be able to grow any type of plants, including leafy vegetables, herbs, coriander, mini fruit trees and medicinal herbs. T-Farm is defined as an indoor garden with all functions automated. We just need to sow the seeds and choose the plants on the app. Watering, nourishing to the plants and lighting help photosynthesis plants be done automatically. (T-Farm, 2019)

Automatic vegetable growing machines are designed as individual modules, so they can be flexibly arranged in different spaces in the office, and change positions as needed. Using a variety of automatic vegetable growing machines designed to suit the general interior space of the office will help increase the green space, beautifying the interior space. The automatic operation mechanism saves care time while still providing the necessary amount of organic vegetables for office employees.

Figure 14: T-farm automatic planting machine (T-Farm, 2019).

7 Conclusion

Society is becoming more modern and developed. Office buildings appear more and more, requiring more office building designs. Green architecture in office building design has been widely applied in the world. Vietnam has also given more attention to green architecture and green office design solutions in recent years. This makes Architects' Teaching to master the principles and standards of green design very necessary in the current period, requiring architectural training universities to try new directions and change project teaching methods. Training should be linked to the reality of business needs as well as the development of society and technology science. The application of Urban Agriculture in green office buildings design is an indispensable trend now, both for creating green spaces in the office and creating a self-sufficient organic fresh food source for people's meals. Therefore, the design solutions that bring Urban Agriculture into the office should become the new design principles and standards when teaching office building design projects for Architectural students.

Urban Agriculture has been contributing greatly to solving difficult problems experienced by countries in the urbanization process. Urban Agriculture will continue to be the solution and strategic direction for the rapid and sustainable development of eco-cities in the future, as well as new training directions for Architectural students. Vietnam is also approaching this model in design as well as training Architects at universities, in order to create a generation of Architects with the capability to designing green and sustainable cities in the future.

References

Huong-Giang. 2018 (10 March). *Urban agriculture will be an inevitable development trend.* https://vov.vn/.

Luc-Binh. 2018 (24 December). *"Greening" the office: The inevitable trend of the future.* http://reatimes.vn/.

Hong-Nhung. 2018 (04 April). *Unique with the 9-Floors office building growing vegetables in Japan.* https://tintucvietnam.vn/

ABIGAIL BEALL FOR MAILONLINE. 2016 (22 February). *The eco-friendly tower blocks that produce MORE energy than they use: 'Hyperion' designs feature 1,000 homes, gyms and farms.* https://www.dailymail.co.uk/.

Bitexco Financial Tower. www.bitexcofinancialtower.com/.

Babylon Landscape. 2018. *Solutions for sustainable green office*. https://canhquanbabylon.vn/.

Dezeen awards. 2019. https://www.dezeen.com/awards/2019/shortlists/vo-trong-nghia-architects/.

Ngo, V.Q. 2016 (24 October). *Prospects of LED lighting applications in high-tech agriculture in Vietnam.* https://anhsangvacuocsong.vn/.

Aquaponics. 2017. *Aquaponics vegetable model has 3 methods.* https://rauxanhcasach.vn/.

Phan, L.C. 2017 (05 May). *Chapter 1: Introduction to Aquaponics*. https://phanlecuong.com/.

T-Farm. 2019 (11 May). *What is T-Farm? Why should you own a T-Farm garden?* https://t-farm.vn/.

Greenbot. 2017 (20 September). *How to grow vegetables automatically?* https://greenbot.vn/.